PATENT SPECIFICATION

DRAWINGS ATTACHED

900,672

Date of Application and filing Complete Specification Oct. 13, 1959.

No. 34721/59.

Application made in Japan (No. 11988) on April 16, 1959.

Complete Specification Published July 11, 1962.

Index at acceptance:—Class 89(1), A(2A:6).

International Classification:—F06b.

COMPLETE SPECIFICATION

Improved Fastening Assembly

We, THE YOKOHOMA RUBBER COMPANY LIMITED, a corporation organised under the laws of Japan, of 9, Shiba-Tamuracho-5-chome, Minato-ku, Tokyo, Japan, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an improved fastening assembly, and more particularly to an assembly for fastening a part or member of a machine or the like to another part or member thereof by utilization of screw threads.

In the past, in fastening together two parts of a machine or the like by the engagement of an externally threaded member, such as a screw or bolt, with internal screw threads formed on the inside of one of the mating parts, or by the use of a stud bolt screwed fast into one of the two parts and a nut threaded over the stud bolt to clamp the other part between said one part and the nut, a spring washer has generally been interposed between that part being clamped and the nut or bolt-head for the purpose of preventing any loosening of the engaging threads under vibration or from deformation of the threaded parts. However, it is found that a spring washer, interposed as aforesaid, is hardly dependable as a means for preventing loosening of the fitting threads, especially when used in vehicles, aircraft or other applications subject to severe vibration, and that therefore this spring washer arrangement shows a deficiency in this respect.

It is an object of the present invention to provide a screw fastening assembly which eliminates the above deficiency, and which is free from loosening even when subjected to severe vibration or deformation of the threads during service of longer periods.

Another object of the present invention is to provide a screw fastening assembly having a helically coiled element in threaded engagement with the screw threads of the internally threaded member, said coiled element having, at one end, one or two of the coil turns disposed within a portion of the axial bore of the internally threaded member having no screw thread.

Yet another object of the present invention is to provide a screw fastening assembly, in which said helically coiled element is secured to the internally threaded member by means of a locking key.

According to the present invention, a fastening assembly compaises an internally threaded member, an externally threaded member, a non-threaded counterbore portion formed in continuation with the threads of said internally threaded member, and a helically coiled element screwed into said internally threaded member, said helically coiled element comprising a metallic wire of substantially rhombic cross-section so that its configuration substantially conforms with that of threads of said internally threaded member and of said externally threaded member, at least one turn of said helically coiled element being positioned within said non-threaded counterbore portion.

Thus an externally threaded member, for example a screw, indirectly engages an internally threaded member for example, a nut, through a helically coiled element instead of being brought into direct contact with the internally threaded member, the helically coiled element comprising a metallic wire of substantially rhombic cross-section helically coiled with the same pitch as that of the screw threads of the mating members, so that the coiled element may properly engage such threads. The metallic wire, of which the coiled element is comprised, has a cross-section of such configuration that the outer half of the cross-section substantially conforms to the space defined between two adjacent internal

[Price 4s. 0d.]

threads of the nut while the inner half of the cross-section substantially conforms to the space defined between adjacent external threads of the screw. In other words, the outer and inner spaces defined between adjacent turns of the helically coiled element substantially conform to the internal and external threads, respectively, of the mating threaded members.

The helically coiled element of the present invention is thus adapted to be screwed into the internally threaded member. The internally threaded member has a bore, an end portion of which is not provided with screw threads, but has an enlarged internal diameter. This enlarged portion extends longitudinally over an axial distance corresponding to the pitch or twice the pitch of the screw thread. The internal diameter of this non-threaded portion is slightly larger than that of the bottoms of the valleys of the screw threads formed in the remaining portion of the bore.

The helically coiled element threaded in the internally threaded member is joined to said internally threaded member by the provision of a key or locking member so as to permit the end turn or turns positioned in the non-threaded portion to move for increasing or decreasing the diameter of said helically coiled element.

It will be understood that, when the coiled element is positioned in the internally threaded member as described above, the coiled element has at one end one or two turns of the coil disposed within that portion of the screw-receiving bore which has no screw threads.

When the helically coiled element is screwed into the screw threaded bore having the non-threaded portion, at least one turn is positioned in the non-threaded portion.

As a screw or an externally threaded member having a head portion, such as a screw bolt, is screwed into the helically coiled element which had already been inserted into the internally threaded member, that turn or those turns of the coiled element which is or are free in the non-threaded portion, is or are radially expanded, and frictional engagement is effected between the outer peripheral edges of such turn or turns and the inner surface of the non-threaded portion, thereby producing a very strong fastening effect. The free turns or turns positioned in the non-threaded portion of the internally-screw-threaded member is or are thus pressed against the underside of a machine part interposed between the head of a screw and the upper surface of the internally threaded member and against the peripheral wall of the counterbore. As the free turn or turns of the helically coiled element is or are pressed as mentioned above, the rotation of the screw shank in the direction of propelling it into the helically coiled element, in addition to the engagement by the pressing, causes the coiled element to expand radially outwards. Such frictional engagement and expansion of the coiled element radially outwards cause the turn or turns free from the threads of the screw bore, but engaged by the thread of the shank screwed into the coiled element, to engage the inner surface of the non-threaded portion of the bore with extremely strong frictional engagement.

When the screw shank, screwed into the helically coiled element in the screw threaded bore, tends to be loosened by rotation in the opposite direction, the above mentioned frictional engagement of the free turn or turns remains as it is, while the turns of the coiled element in engagement with the screw threads of the bore are caused to contract radially and to grip the screw shank strongly. The intensity of this gripping engagement, as the shank tends to be loosened, is greater than that between the free turn or turns and the non-threaded portion of the bore. An important advantage of the fastening assembly according to the present invention is that a larger torque is needed in a loosening operation than that needed in a fastening operation.

Advantages of the present invention will be apparent from the following detailed description when read with reference to the accompanying diagrammatic drawings, in which:—

Figure 1 is a longitudinal cross-section of a nut embodying the present invention;

Figure 2 is a plan view of the nut of Figure 1;

Figure 3 is a cross-section of another embodiment of the present invention, in which the internally threaded member is shown in the form of a plate having a substantial extent, with a bolt as an externally threaded member loosely threaded into the plate;

Figure 4 is a view similar to Figure 3, but showing the bolt screwed up tightly; and

Figure 5 is a graphical representation showing the relationship between the turning torque and the angle of revolution of the screw fastening assembly of the present invention, and in a conventional screw fastening device employing a spring washer.

Referring to the accompanying drawings, particularly to Figure 1, there is shown a nut 10 according to the present invention. Axially threaded in the threaded bore of the nut 10 is a helically coiled element 12 made of No. 303 stainless steel, of substantially rhombic cross-section, and coiled to have such a configuration that the outer half of the cross-section of respective turns of the coil conforms to the space defined between adjacent internal threads of the nut 10. In this case, the threaded bore of the nut as an internally threaded member, is counterbored or circumferentially recessed at one end to a depth or over an axial distance corresponding to twice the pitch of the internal threads,

said counterbore or circumferentially recessed portion 15 of the threaded bore having a diameter slightly larger than the major or full diameter of the internal threads of the nut 10. The helically coiled element 12 has an outside configuration substantially conforming to the internal threads of the nut, as described above, with the axial thickness of the coiled wire corresponding to approximately seven eighths the pitch of the coil or of the screw threads. The helically coiled element 12 is formed with a recess 13 comprising aligned slots formed in respective turns of the coil in such a manner that said recess 13 as a whole extends opposite a recess 11 of the nut defining a key way for co-operation with the recess 11 when the coiled element 12 is in place within the threaded bore of the nut. Said key-way, defined by the recesses 11 and 13, is adapted to receive a key 14 for firmly securing the coiled element 12 to the nut 10, as illustrated.

Alternatively, the threaded bore of the nut may be counterbored or circumferentially recessed at one end to a depth or over an axial distance corresponding to the pitch of the internal threads, instead of to a depth or over an axial distance corresponding to twice the pitch of the internal threads.

It will be observed that the helically coiled element 12 is formed so that its outside configuration substantially conforms to the internal threads of the internally threaded member while at the same time the inside configuration of the element 12 substantially conforms to the threads of the externally threaded member to be threaded into the coiled element 12.

Figure 3 illustrates a machine part 16, of a substantial extent, having a threaded bore according to the present invention. It will be observed that the threaded bore formed in the part 16 is counterbored or circumferentially recessed at one end to a depth or over an axial distance corresponding to two turns of the internal threads, said counterbore or circumferentially recessed portion 17 of the threaded bore having a diameter slightly larger than the major or full diameter of the internal threads.

In Figure 3, another part or a plate 18 is shown fastened to the part 16 by a screw fastening means including a bolt or screw 19. As will be seen in Figure 3, the threaded bore of the part 16 has a helically coiled element 20 threaded therein in accordance with the teachings of the present invention. Also in this case, the coiled element 20 is locked or held in place within the threaded bore of the part 16 by a key and key-way structure as described with reference to Figure 1.

As illustrated, the screw 19 is threaded into the helically coiled element 20 through an opening 21 formed in the plate 18 placed on the part 16. At this time, the screw 19 is only loosely fitted in the coiled element 20 and the plate is not pressed heavily against the part 16 by the head 22 of the screw 19.

However, as the screw 19 is further screwed in to effect good frictional engagement with the helically coiled element 20, the latter is pressed radially outwardly and upwardly by the screw threads of the screw 19 so as to engage firmly the internal threads of the part 16 as an internally threaded member, as shown in Figure 4. At the same time, the end turn 23 of the coil disposed within the counterbored non-threaded portion 17 of the bore is pressed in the counterbore or the non-threaded portion 17 by the bottom surface of the plate 18, and the free turns postioned in the non-threaded portion are forced radially to engage the inner wall of the non-threaded portion 17. Thus, the screw 19 acts to engage the part 16 firmly, thereby fastening together the plate 18 and the part 16 tight and fast.

In the foregoing, fastening assembly has been described as comprising an internally threaded member having a helically coiled element threaded therein and firmly secured in place by means of a key or key-way structure. In actual practice, however, especially in manufacturing threaded parts such as nuts in large quantities, use of the die-casting process is preferred. In this process a helically coiled element is properly placed in a suitable die, which element has aligned slots formed in respective turns of the coil so as to define a continuous longitudinal recess as in the embodiment shown in Figure 1. A suitable alloy is then cast around the coiled element in the usual way. Only, in this case, a ring core is employed in the die around the top portion of the coiled element to form an enlarged bore as indicated at 17 in Figures 3 and 4, so that at least one complete turn of the coil at the upper end thereof is free from the cast metal.

The manner in which an externally threaded member, such as screw 19, and an internally threaded member, such as nut 10, or part 16, are brought into firm engagement with each other when screwed up tight will be further clarified by the following description with reference to Figure 5 illustrating the relationship between the turning torque and the angle of revolution of fastening screws. In Figure 5, the dotted curve indicates such relationship as obtained from a test conducted with a conventional fastening system or assembly in which a spring washer is utilized between the bolt head and a part to be fastened. It will be noted that, with the conventional system or assembly, the turning torque shows no appreciable increase, after the screw has begun to tighten, until the screw has turned through an angle of the order of 270 degrees, as indicated by the part a^2 of

the dotted curve shown in Figure 5. As the screw is further turned, the torque sharply increases, as indicated by the part b^1 of the dotted curve, and reaches, say, fifty inch-pounds as at I to complete the tightening. Point I corresponds to an angle of revolution of approximately 315 degrees measured from the origin or starting point at which the torque begins to increase. When the screw, thus threaded tightly, is loosened, it is of course turned in the opposite direction. However, with such conventional system or assembly, as the screw is turned in the loosening direction, the turning torque suddenly decreases to point II with an extremely slight rotation as indicated by the part c^1 of the dotted curve shown in Figure 5, and further decreases along the part d^1 of the dotted curve to reach zero at point III which corresponds to an angle of rotation of approximately 160 degrees as measured from the origin at which the torque begins to increase. Such characteristic curve indicates that, when the screw or bolt is turned in the loosening direction, the turning torque not only suddenly decreases, but that furthermore the turning torque is reduced to zero when the screw or bolt has been brought only to a point corresponding to 160 degrees, measured from the origin.

With a fastening system or assembly in accordance with the present invention comprising an internally threaded member having a helically coiled element secured thereto, the turning torque required for tightening the screw or bolt rises as shown by the solid curve *a* in Figure 5. The rise of the turning torque becomes sharp when the screw or bolt has been turned through approximately 200 degrees and follows the line *b* until it reaches point 1, which corresponds to, say, fifty inch-pounds, to complete the tightening operation.

With the system or assembly according to the present invention, a surprising phenomenon occurs when the screw or bolt, thus tightened up, is loosened. It is found that the screw or bolt cannot be loosened with respect to the nut or internally threaded member unless there is employed a turning torque much greater than, for example 1.5 times is great as, the torque required for tightening the same screw or bolt. In Figure 5, as the screw or bolt is turned in the loosening direction, the turning torque required rises from point 1 along the solid line *c* to point 2, which corresponds to eighty inch-pounds, and thereafter decreases to point 3 to follow the tightening curve toward the origin.

Thus, with the fastening assembly according to the present invention, a turning torque larger than that for tightening the screw or bolt is required for the latter to be loosened.

It will be appreciated that this is quite effective to prevent unintentional loosening of the screw or bolt due to vibration or from deformation of the screw threads. As aforementioned the cause of this effect is the frictional engagement of the last two turns of the helically coiled element with the inner surface of the non-threaded portion 15 or 17.

With the fastening assembly according to the present invention, since a turning torque greater than that required for tightening is necessary for loosening, as described above, and since the fastening effect is obtained by frictional engagement of the screw or externally threaded member and the nut or internally threaded member through the intermediary of a helically coiled element as distinct from the conventional system or assembly where the fastening effect is obtained by direct frictional engagement between the part to be fastened and the screw or the nut, as the case may be, there is provided an advantage in that no loosening occurs between the threaded members even when they are employed to fasten a part or parts which is or are easily deformable under the tightening effect of the co-operating threaded members.

WHAT WE CLAIM IS:—

1. A fastening assembly comprising an internally threaded member, an externally threaded member, a non-threaded counterbore portion formed in continuation with the threads of said internally threaded member, and a helically coiled element screwed into said internally threaded member, said helically coiled element comprising a metallic wire of substantially rhombic cross-section so that its configuration substantially conforms with that of threads of said internally threaded member and of said externally threaded member, at least one turn of said helically coiled element being positioned within said non-threaded counterbore portion.

2. A fastening assembly as claimed in Claim 1, in which the helically coiled element is locked within the non-threaded portion of the internally threaded member by a key or locking member.

3. A fastening assembly substantially as hereinbefore described and as illustrated in Figures 1—4 of the accompanying drawings.

For the Applicants,
CARPMAELS & RANSFORD,
Chartered Patent Agents,
24, Southampton Buildings, Chancery Lane,
London, W.C.2.

Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1962.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.